



## Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

# THE SCIENTIFIC MONTHLY

---

FEBRUARY, 1918

---

## WEATHER CONTROLS OVER THE FIGHTING IN THE ITALIAN WAR ZONE

By Professor ROBERT DE C. WARD

HARVARD UNIVERSITY

SO obvious have been the weather controls over military operations in the present war, that even the layman has not failed to note the importance of this factor in the course of his reading of the war news in his daily paper. In every-day conversation mention has often been made of the rain and the mud in Flanders; of the heat and drought of Mesopotamia; of the snowstorms of the Trentino; of the hazy spells usually selected by the Germans for their air-raids on England. The subject is one which merits careful study. It has an interest as a matter of historical record. But it also has a very immediate and a very practical side. By means of daily weather forecasts, such as are now being made by the expert meteorologists on all the war fronts, the military commanders are often able to plan operations in such a way as to take advantage of weather conditions favorable to their purposes, and, at least to some extent, to guard against those conditions which are hostile. Again, a knowledge of the climate and weather of the different war zones, and the experience which the armies have already had with them, may be of immense benefit to us, now that American troops are already on the firing-line on the western front and may soon also be engaged on other fronts. For our military tactics; the clothing and equipment of our troops; the whole matter of our transport; the organization of our aviation service, all depend, far more directly than most people realize, upon the weather. With the matter of daily forecasts, the present paper is not concerned. What is here attempted is to bring together such meteorological facts and controls, from one of the most interesting of all the war zones, as may help in an understanding of the campaign in that area up to this time, and may, if American troops are sent there, be of practical service.

In the matter of meteorological interest, the most dramatic fighting thus far during the war has taken place in the mountains. In the earlier months of the war, the Russians against the Teutonic allies in the Carpathians; somewhat later, the Russians against the Turks in the Caucasus and on the highlands of Asia Minor; and, since the spring and summer of 1915, the Italians against the Austrians and now against the Germans, in the Alps, have had the hardest fighting against weather conditions. Because of the present interest in the Italian war situation, the present paper will deal with some of the larger and more striking weather controls in that particular area.

There are three subdivisions, climatic as well as topographic, of the Italian war zone: the Alps of the Trentino, the Carso plateau in the east, and the northern lowland. Of these, the Alpine section has been the scene of the longest fighting, and also presents the most striking meteorological controls. It is, therefore, here first considered. No other part of the Great War has been fought for so many months under equal conditions of hardship. Nowhere else has the struggle between man and man been accompanied by so continuous a struggle between man and nature.

The Alpine complex lies as a barrier between the climates of northern and western Europe, with their relatively mild winters, moderate summers, and rainfall fairly well distributed throughout the year, and the Mediterranean province on the south. The latter, because of its irregularity of outline, vertical as well as horizontal, has many varieties of climate, all relatively mild, except at higher elevations, and with winter rains over most of the area. Owing to the great diversity of Alpine topography, it is impossible to give any detailed description of the climates of the peaks, the slopes and the valleys. Moreover, sufficient meteorological records are lacking for such a presentation. In any such varied topography, temperature, humidity, cloudiness, rainfall, snowfall, winds, are so largely controlled by local conditions of altitude, of exposure, of the immediate surroundings, that every place has, in a sense, its own climate. The effect of altitude upon temperature is often offset by the control due to topography or to exposure. The severe winter cold of the deep valleys during clear, calm spells seems less unbearable than higher temperatures, accompanied by furious gales, on the mountain peaks and upper slopes. Thus, while a detailed description of climates is out of the question, it is also true that a generalized account must be very broad. This much may be said: High mountains mean cold and snow, even in summer. They mean more clouds and rain and thun-

derstorms than the lowlands have. They mean more wind; more violent storms; deeper snows; a harder struggle against the elements. Severe, indeed terribly severe, have been the meteorological handicaps in that mountainous country where fighting has been going on in the clouds, amidst ice, and deep snows, and avalanches.

The war in the Alpine sector began in the warmer months of 1915. Yet even in that milder and more peaceful season of the year, weather controls at once played their part. Late spring and mid-autumn are times of frequent and heavy rainfall in that region. Hence swollen rivers, flooded passes, deep mud, "bad weather," were to be expected and were experienced, even in summer. Over and over again, heavy rains and "fog" checked the fighting. These "fogs," often mentioned in the despatches, are doubtless in most cases not real fogs, which lie on the ground, but clouds, for much of the fighting has taken place at altitudes well within the cloud zone. Such "fogs" often interfered with artillery firing and with aeroplane observation, but were several times taken advantage of, by one side or the other, for making surprise attacks. Summer lightning played among the troops fighting on the rocky mountain-sides. Torrential downpours swept the passes and temporarily stopped engagements. Hail beat in the faces of the men as they charged up the steep slopes. In view of the well-recognized importance of snow in the later (autumn-winter, 1917) developments along this Alpine front, it is worth noting what the conditions were earlier in the campaign. June 21, 1915, a despatch from Brescia noted the occurrence of a heavy snowstorm on Monte Altissimo, with temperatures below zero (C.). The despatches of June 24 mentioned that there were more than 2 feet of snow on the lofty Stelvio pass, where spirited fighting was going on. On July 1, 1915, it was reported that "the mountaineers (Tyrol) do not remember a season when there has been so much snow on the heights on July 1. The mountain streams, which are usually dry at the end of June, are now deep and almost impassable. The Italian troops are encountering snowstorms and thick fogs, which have interfered with long-range firing." Snowfalls toward the end of September, 1915, checked the fighting.

The two winter campaigns (1915-16, 1916-17) in the Alps brought, as was to be expected, snows many feet deep; howling gales, avalanches, and bitter cold. Under such conditions large-scale operations were not possible. Many precautions had to be taken. Snowshoes and skis, extra-heavy clothing, blankets, fur chest protectors and sleeping-bags, and foot-warmers were

supplied. White coverings were worn for protection amidst the snows. To supply the troops with warm clothing, offices were opened in the Italian cities, where furs of all kinds were brought in to be made into winter garments. Provisions were assembled in specially-constructed weatherproof huts. The shelters for the men were fitted with stoves. The trenches were lined with straw and boards. Special arrangements were made for supplying hot rations to the troops. Galleries dug under the snow were several times used as a means of approaching the enemy's trenches. In spite of all precautions, hundreds of the troops were invalided home with hands and feet frost-bitten.

After the remarkable Teutonic offensive, in mid-autumn, 1917, which brought the Austro-German troops down on to the plains of northern Italy and for a time seriously threatened Venice, military operations were suddenly and most aggressively renewed in the Trentino sector, chiefly in the region of the Asiago plateau. The enemy made desperate attempts to capture the mountain positions and to penetrate on to the lowlands, in order to turn the Italian left flank and thus make the Piave line untenable before winter should make such a task impossible because of snow-blockades in the mountains. Once again the terrible winter weather of that rugged country played its part in the fighting. The Teutonic advance began "in driving snow, and cold, and pouring rain" (second week, November, 1917). The official and other despatches mention bitter cold (November 27, 14° F.) ; lack of shelter owing to the terrific artillery action and the constant shifting of positions; insufficient supplies of water; drifting (though light) snow; biting winds; the use of caves "from which hung huge icicles" for shelter. One account notes the fact that the Italians were often "compelled to remain motionless for a long time lest they should be discovered by the enemy against the whiteness of the snow."

That the coming on of winter at once, and in full vigor, with deep snows, and raging "blizzards," would have been the best possible ally to the Italians, was well recognized by all the military commanders. For in normal winter weather, the Teutonic lines of communication both by railroad and also by the narrow mountain roads, would be paralyzed, or at least badly blocked, and the transport of heavy artillery, of munitions and of supplies would become difficult or impossible. Each additional day that the Italians were able to delay the advance of the Austro-German armies brought winter's help one day nearer. Each day made the Teutonic offensive more difficult. It is,

therefore, easy to understand why the enemy's general staff was ready to make such continuous and desperate attempts to break through before the worst of the winter weather should come on. The fighting was against time. A winter campaign on the lowlands is far more practicable than in the mountains, owing to milder weather, and little snow. From numerous reports, coming from various sources, it is clear that the early part of the present winter (1917) was unusually favorable to the enemy. It was cold, but usually clear, and the heavy snowstorms characteristic of the late fall and early winter were entirely lacking. The snow, instead of being several (5-10) feet deep in the mountains, as it was a year ago in November and early December, was (up to mid-December) only a few inches deep in most places. A despatch of December 6 said that one deep snowfall "would be worth divisions to the Italians." Gen. Diaz said on December 9, "with normal winter conditions prevailing in the north, the enemy would now be in the grip of impassable snows." Small wonder is it that the Italians prayed for snow in the mountains; and for an end of what they termed "Austrian weather" which they felt had lasted from the first day of the retreat from the Isonzo front. Light snows fell from time to time, but the long-hoped-for deep snows did not come. It is always natural that man should overestimate, or underestimate, the extent of meteorological conditions which are helping or hindering him in warfare. Hence it is both interesting in the present survey, and as a matter of historical record, to give here an Associated Press despatch, dated Italian Army Headquarters in Northern Italy, December 25, which gives, on the authority of an Italian meteorological expert, the actual conditions as to the meteorological characteristics of the early winter of 1917.<sup>1</sup>

The entire mountain region, where heavy fighting has been going on in recent days, is having the unusual experience of a holiday season with green slopes and summits and little or no snow. One of the generals on the front said that every foot of snow was worth divisions in obstructing the enemy.

"This is one of the mildest winters we have ever had," said the major in charge of the weather branch of the high command, "and from a military standpoint the weather conditions are of the highest importance both for our troops and, particularly, in their effect on the enemy's transportation of supplies and troops."

Taking the report furnished by the high command to-day on the

<sup>1</sup> The special meteorological service organized in connection with the Italian military staff has already published several bulletins dealing with military meteorology. Among the subjects so far considered are the climates of the various districts within the war zone, also details regarding avalanches, with lists of places especially subject to them.

weather at all vital points, the major pointed out the extreme variation in the mountains, plains and valleys.

Here at headquarters the report showed two degrees above zero Centigrade (35.6° Fahrenheit) and no snow, while the same report showed —15° Centigrade (5° Fahrenheit), and seven feet of snow in the Ortler Alps.

Further east, in the Adamello Alps, which are the next highest to the Ortler, there are about three feet of snow as compared with nine feet last year.

Around Lake Garda the condition is much milder. Monte Pasubio, where the Austrians made their big drive last year, now has four feet of snow, as against twelve feet last winter. But all these snow-covered points are in the active military region for the present.

The entire area of the present fighting in the Brenta valley is free from snow and the weather is mild. This is the valley where the Austrian route brings supplies and troops from Trent and the Asiago and Brenta fronts. Between the Brenta and the Piave rivers, which is the principal region of the fighting, Monte Grappa, which usually has four to six feet of snow, now has only ten to twelve inches on the northern slopes and six inches on the southern slopes. The temperature is from —5° to —12° Centigrade (23° to 10.4° Fahrenheit).

Montes Asolone, Pertica and Bolarolo, where the heaviest fighting has occurred in the last few days, have only a few inches. It varies from three to five inches and seldom lasts, owing to the mildness. In the foothills there is no snow and the temperature is always above freezing.

The reports show similar mild conditions in the Carso and the Julian ranges to the east, through which the Austrians maintain their communications with the invaded regions of eastern Venetia. The mildness is so pronounced that the enemy is able to operate four distinct lines of communication leading to Gorizia, Udine and Venetia.

The unusual weather conditions are proving an important factor in the campaign, for while severe cold and heavy snows would hold the enemy in their grip, the present mild and almost snowless season permits operations to proceed.

Late in December (31st), the despatches noted the fact that enough snow had fallen to make transportation difficult.

One larger consequence of a slackening of operations in the Trentino sector may be mentioned. Heavy snows there would doubtless mean the transfer of large numbers of Austro-German troops to the western front, to the lowlands, or, in case of an Allied attack on Pola, to that section.

The other portions of the Italian war area, the plateaus (Carso, Bainsizza) in the northeast and the eastern portion of the northern Italian lowland, may, in conclusion, be considered together. For the general temperature conditions of the plateau, the records of three stations, grouped together, at an average elevation of 1,700 feet may be noted. These have a midwinter (January) mean of 30°; a midsummer (July) mean of 66.7°, and an annual mean of 48.4°. Their *average* lowest temperatures in winter are 5.4°; their *average* highest tempera-

tures in summer are  $84.4^{\circ}$ , although in any single year the minima and maxima are likely to vary several degrees lower or higher. For purposes of comparison, Laibach and Trieste may be added.<sup>2</sup>

In winter, the plateau is noticeably colder than the immediate coast, and cold northerly winds are very apt to blow from the interior down to the northern shores of the Adriatic.

Trieste has a mean annual rainfall of 42.83 inches, with an average of 109 rainy days, the rainiest months being June and October; and the driest, December to April and July–August. Göriz has a mean annual rainfall of 63.50 inches; 139 rainy days; maxima in June and October, and minimum in January and February.

More or less fighting has been in progress on the Carso plateau since Italy entered the war. Here, in the late summer and autumn of 1915, the men suffered from the heat, even in their light gray cotton uniforms, and later the general cold-season storms of that region, and the fogs, often interfered with military operations. The time for the great main Italian offensive, about the middle of May, 1917, seems to have been chosen between floods on the Isonzo River. The troops were able to cross on pontoons. Usually at this season the river is practically impassable except on fixed bridges, for this is the time when the spring rains and melting snows in the Carnic Alps cause the rivers to flood. The passage of the Isonzo was forced in a heavy fog. Italy's strong offensive on the Carso plateau could not be begun any earlier on account of "terrible atmospheric conditions." Great difficulty was experienced because of lack of water on this dry plateau. Each day, according to one despatch, 450,000 quarts of drinking water were carried up to the thirsty men. Temporary relief, both in supplying water and in limiting military operations, resulted from thunderstorms and occasional general rains. Early in July (10th) the Austrians began a night attack, on the Vodice, in a violent thunderstorm. In the darkness the enemy had almost reached the Italian positions when a sudden flash of lightning revealed the attacking party, which was completely repulsed. Stifling heat was reported late in August. It is worthy of note that the southern soldiers of Gen. Cadorna's army were espe-

	Laibach	Trieste
<sup>2</sup> January .....	$27.5^{\circ}$	$37.8^{\circ}$
July .....	$67.3^{\circ}$	$73.6^{\circ}$
Year .....	$48.2^{\circ}$	$55.2^{\circ}$
Mean min. ....	$-0.4^{\circ}$	$19.6^{\circ}$
Mean max. ....	$88.7^{\circ}$	$93.9^{\circ}$

The warmer winters of the coast are clearly indicated.



cially mentioned for their valor and fighting abilities during the conquest of Monte Santo. Gen Cadorna evidently pushed his troops to the utmost in order to smash the Austrian armies and to gain as much territory as possible before winter should make large-scale operations impossible. There were signs, also, that Italy was preparing for a winter campaign against Trieste when operations could no longer be continued farther north. There were two classes of difficulties, both directly or indirectly climatic, which added greatly to the already seemingly impossible task of the Italian armies. One of these was the problem of supplying water to the men who were fighting on the dry plateaus and on the mountain slopes far above the rivers. Until pipe-lines could be laid, water was carried up, in small quantities, on the backs of men, to the thirsty soldiers who could often look down, thousands of feet, on to the rivers running in flood far below them. The other difficulty was the stormy autumn weather. Heavy rains changed peaceful streams into raging torrents. Fogs and mists interfered with visibility. Increasing cold added to the discomfort and suffering.

The great Austro-German offensive began in the last week of October. The Italian front lines were broken through (October 24) "in a drenching rain and mist, under the most depressing conditions," which rendered the Italian barrage ineffective in opposing the onslaught. As one correspondent put it, "Austria is hiding behind the skirts of autumn." The Italian mountain positions "were surrounded and made untenable before the fog lifted." The use of deadly gases was favored by a light wind and the damp air. Several days of stormy weather were followed by a fine spell, which favored a rapid advance on the part of the Teutonic troops, across the mountains and through the valleys. During the earlier stages of their retreat, the Italians suffered greatly from cold torrential rains. Much interest centered in the stages of the Italian rivers. It appears that, while the heavy rains added to the difficulties of the hurried Italian retreat, they also delayed the enemy's advance, by swelling the rivers, softening the ground, and preventing effective reconnaissance and bombing on the part of the enemy aviators. The reports regarding the condition of the Tagliamento, the Livenza and the Piave rivers were very contradictory. These are not broad, deep and swiftly-flowing streams, always difficult to cross, but vary greatly according to the rains, becoming shallow during fine spells. Apparently at times the invaders were favored, and at other times the defenders. On the whole, the balance seems to have been in favor of the Teutonic troops. The Piave was reported as

flowing with a full head of water in mid-November, owing to recent heavy rains. These same rains helped to flood the lowlands. The sector of the lower Piave was further rendered difficult to cross by the release of the flood-waters through the opening, by Italian engineers, of the dikes, so that a considerable area to the north of Venice was several feet under water. On December 13 a report noted the occurrence of "downpours" during two days, filling the Piave which had nearly "run dry," and effectively flooding the inundated section over which the waters had fallen from 5 ft. to 1 ft. Taking advantage of this low water, the Austrians had made an advance. The high and low stages of these rivers have been a constantly fluctuating factor in military operations on their banks.

The larger climatic characteristics of the Italian lowland, across which the battle-front now stretches, are well shown in the excellent meteorological records which have for years been kept at several of the larger cities. Thus, Venice, Vicenza and Padua have midwinter (January) mean temperatures of about 35°, midsummer (July) means of about 75°, and mean annual temperatures of about 55°. Venice has the highest values (1.5° to 2° F.) in each case. The absolute minima have been between 7° and 15°; the absolute maxima, between 95° and 100°. Belluno, at about 1,300 ft., has slightly colder winters (30.2°), somewhat cooler summers (69.3°), and a lower mean annual, 50.9°. Its lowest reading is 4° (3.9°) and its highest nearly 100° (99.7°). "Mediterranean" climates are as a whole distinguished by comparatively moderate rainfalls, and by dry summers. These stations on the northern Italian lowland, however, have a somewhat different rainfall distribution. They are alike in having a minimum in the winter, and maxima in spring (May) and autumn (October). The amounts vary as follows: Belluno, 50.67 inches; Vicenza, 47.56 inches; Padua, 33.70 inches; Venice, 29.53 inches. In addition, Udine has a mean annual of 60.94 inches; 145 rainy days; maxima in June and October, and minimum in January-March. In the Venetian Alps the rainfall is much heavier. The number of rainy days is between 100 and 125; the probability of rain usually being greatest in May and October, and least in August.

Northern Italy is on the track followed by storms coming, in winter, from the Gulf of Genoa or from the western and southern Mediterranean, and moving in an easterly or north-easterly direction. These storms bring general rains, and occasionally snow. Snow is, however, infrequent, as is seen by the record of an average of days with snow, as follows: Venice, 2.0; Vicenza, 3.9; Udine, 4.3; Padua, 4.7; Trieste, 6.5.